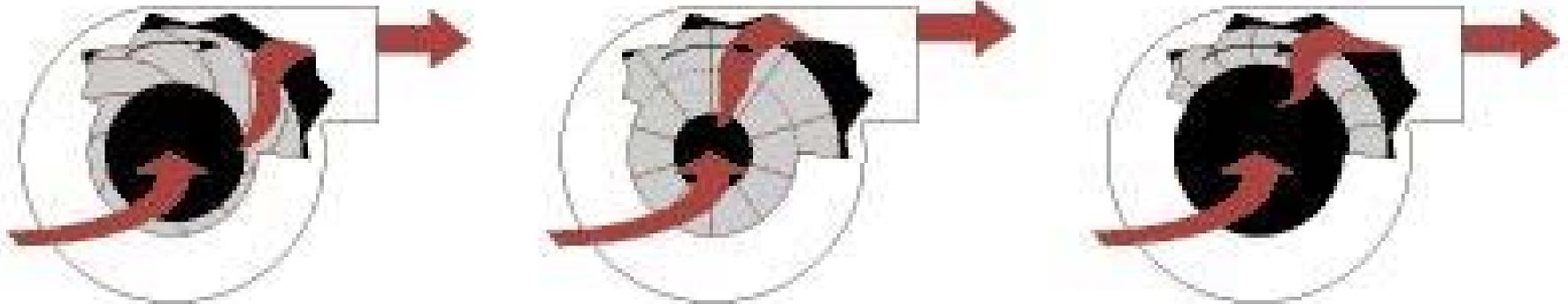




Blower Energy Use

Iain Walker, LBNL

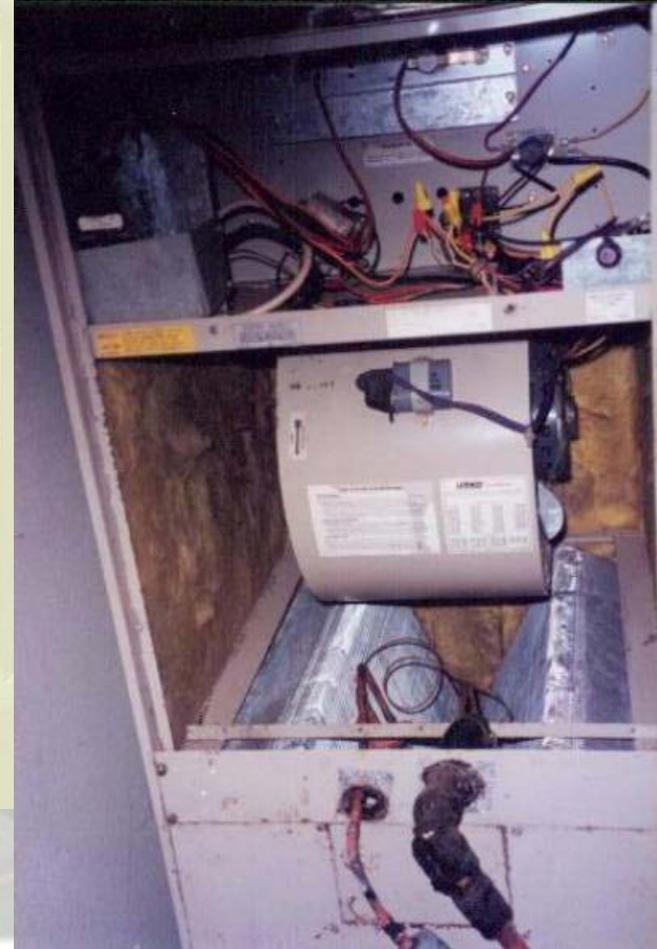


Power Consumption

- Typically about 500W
- Median new construction almost 650W
 - Bigger houses = bigger systems = more fan watt draw
- Heating: less gas used
- Cooling: adds a kW of heating to a 5 ton air conditioner
- Contributes to electricity peak problem

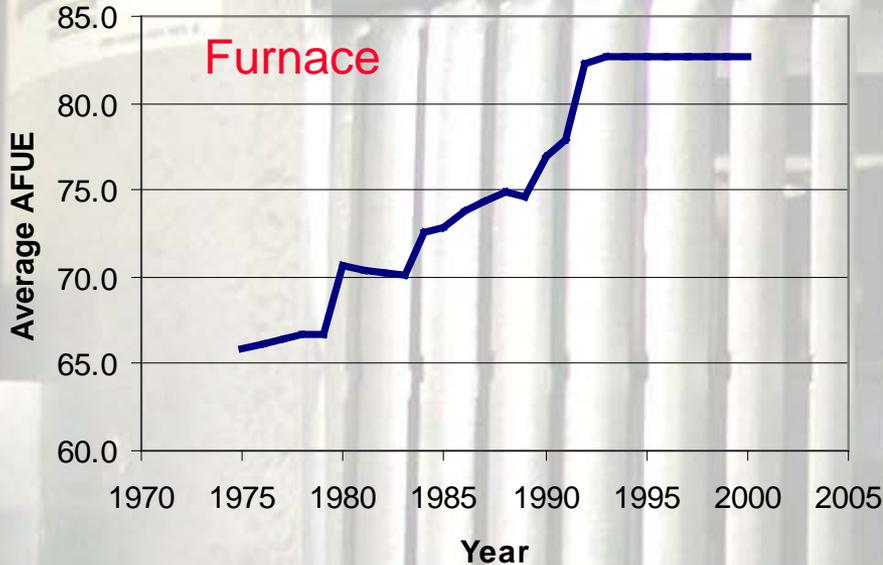
Furnace Blower Energy Use

- National Energy Consumption
 - 0.6 Quads
 - 15 hours of world energy use
 - 10 days of U.S. oil imports
 - 25% market share for good fans would save \$2 billion + 1.2 million tons carbon each year
- Barrier to mechanical ventilation (electricity cost ~ \$500/yr)
- **NOT REGULATED**

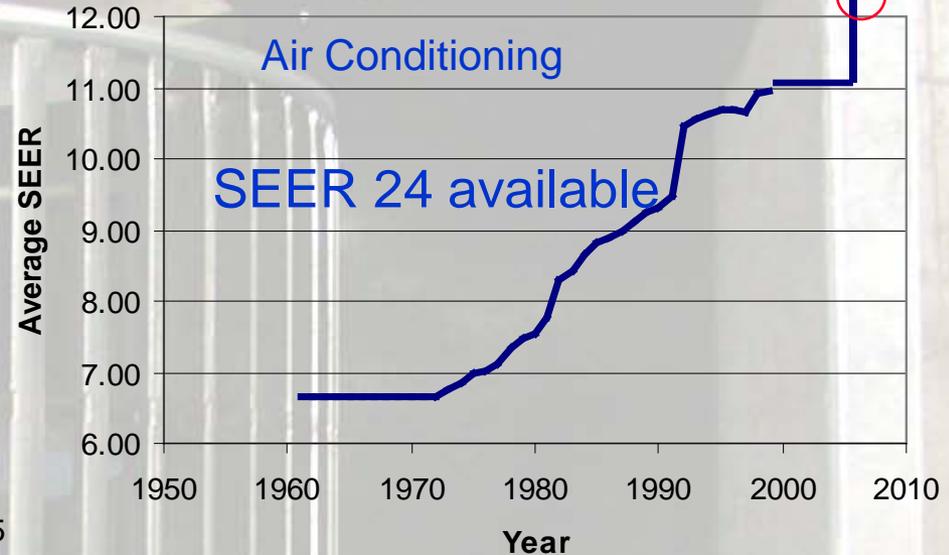


Typical Efficiencies

>95% Available



SEER 13 standard



Furnace Blower < 15%

No high performance alternatives

Poor blowers drop SEER 13 to SEER 12 or worse



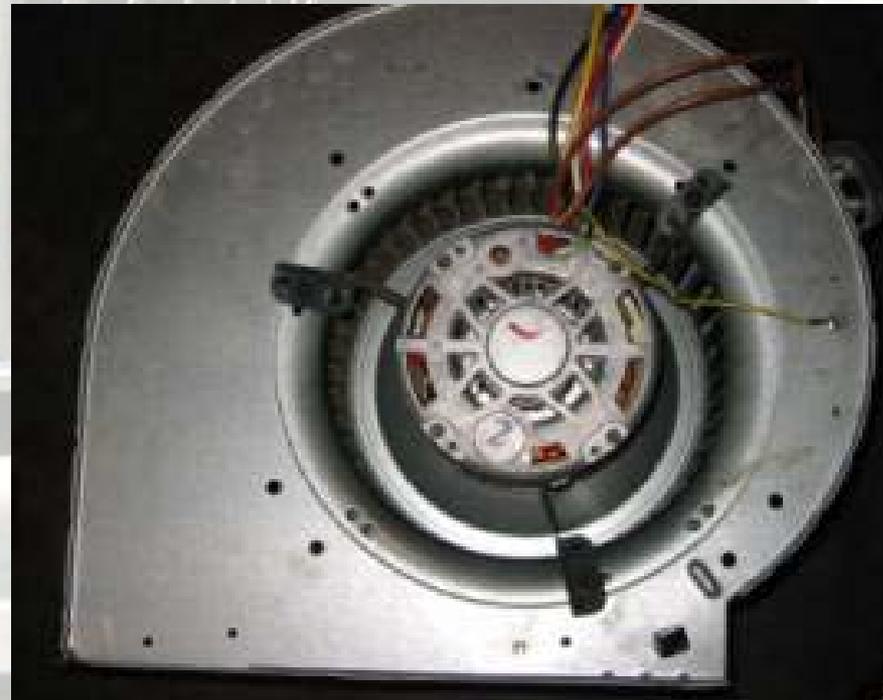
Three Blower Performance Issues

1. Electric Motor
2. Blower wheel and housing - Aerodynamics
3. Installation

Blower Performance Issues

1. Electric Motor

- 60% efficient – depends on speed, load and motor type



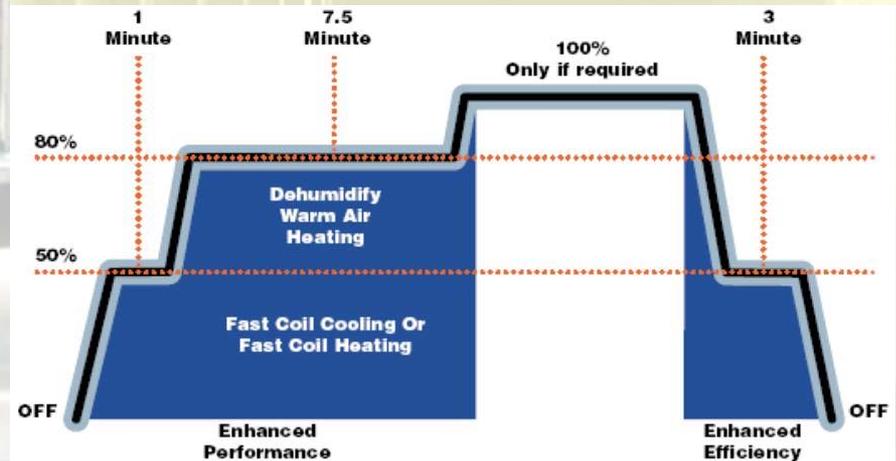
Two Types of Motor Currently Available

Permanent Split Capacitor (PSC)

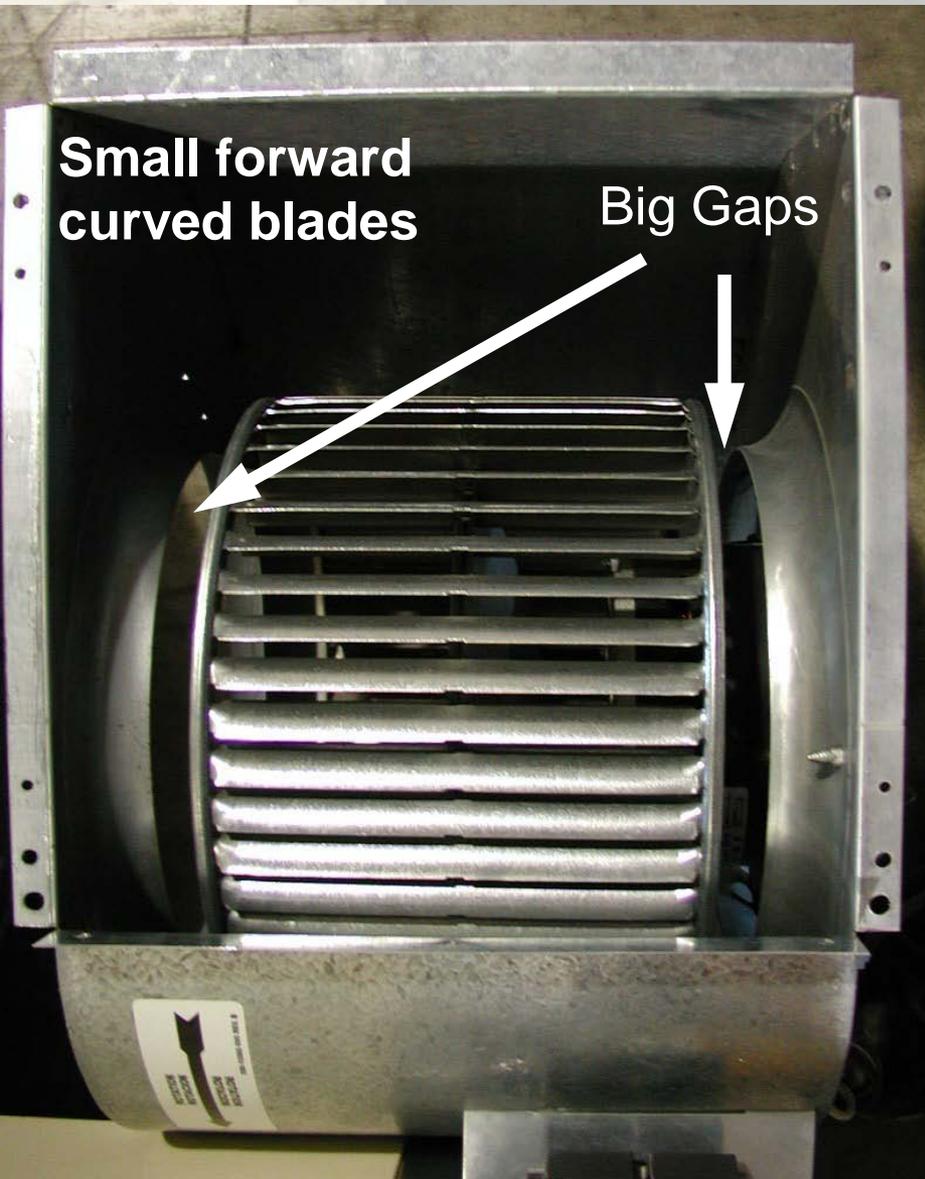
- 6 pole induction motor
- Most common (>90% of market)
- Multiple “Fixed” Speeds controlled by slip from 1200 rpm synchronous speed

Brushless Permanent Magnet (BPM)

- Rotor is permanent magnet
- Speed controlled electronically by switching armature current
- Controls able to maintain flow over wide pressure range
- In most high-end equipment
 - High SEER
 - Gradual start-up
 - Humidity control



Blower Performance Issues



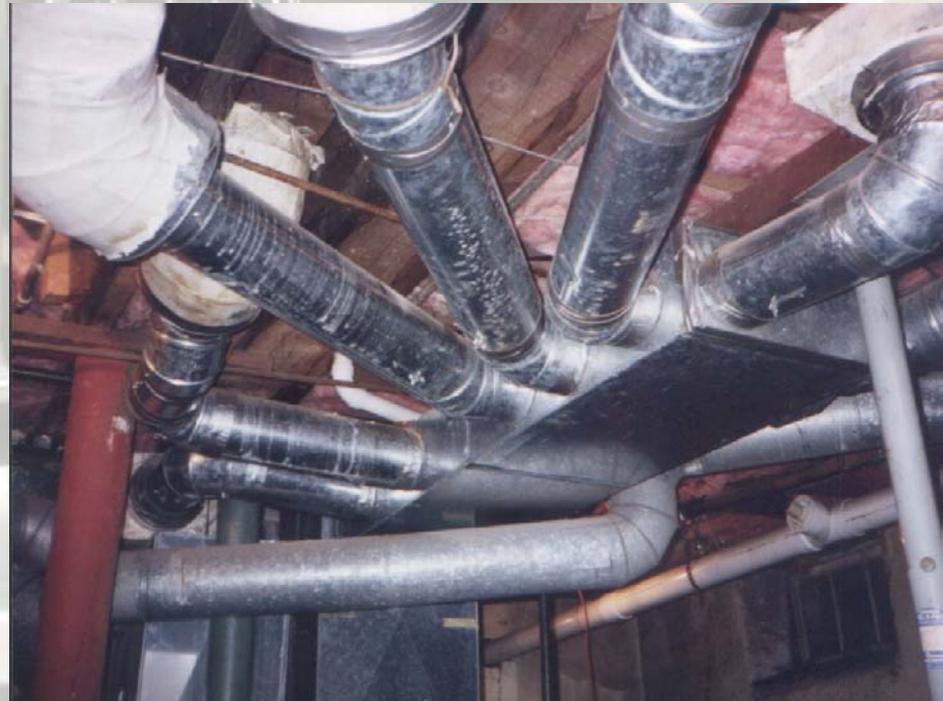
2. Blower wheel and housing

- Aerodynamics – 0 to ??% efficient
- Typically 25% efficient
- Big gaps
- Restrictive cabinets: big fans in small boxes – cabinet size restrictions

Blower Performance Issues

3. Installation

Duct system flow resistance (static pressure difference): ducts, coils, filters, dampers



Field Surveys

About 500 houses total: CA, NV, Energy Star Texas homes, Wisconsin, Florida, Canada, Texas

Contractors, researchers, utilities,
...everyone agrees

- 2 cfm/W
- Duct static pressures are too high..
 - = 0.5 in water (125 Pa) heating
 - = 0.8 in water (200 Pa) cooling

Pressure Drop Breakdown – 60 New California Homes

- Total External Static = 0.8 in. water (0.5 in. water if no cooling coil)
- Cooling Coils - 0.3 in. water
- Ducts (sum of supply, return and filter) – 0.5 in. water
 - Supply – 0.2 in. water
 - Return – 0.15 in. water
 - Filters - 0.15 in. water
- Internal to fan – can't change this & no good data

Need to control these system pressures

Fixing Duct Pressure Drop

- Bigger ducts
- Multiple returns
- No excess flex duct
- No flex duct compression
- Short ducts
 - Better envelopes – no ducts to perimeter short ducts or directly put vents in plenum for small house
 - Cheaper!
- Grilles
 - Some grilles better than others
 - Look for aerodynamically smoother vs. pressed steel

Duct Flow Resistance vs. Ratings

AFUE No filters or cooling coil
0.23 in. water c/w 0.5 in. water

ARI includes filters and supplementary heating coils
0.15 in. water c/w 0.8 in. water

Table 4
Relation of Furnace Input to Minimum Static Pressure*
for Performance and Rating Test Purposes
(all tests performed without a filter)

Input to Furnace (Btu/h)	External Static Pressure (in. water)		
	Oil Furnace with a Temperature Rise Less Than or Equal to 65°F	Oil Furnace with a Temperature Rise Greater Than 65°F	Gas Furnace
55,000 and under	0.38	0.18	0.18
Over 55,000 to 80,000	0.38	0.20	0.20
Over 80,000 to 100,000	0.38	0.23	0.23
Over 100,000 to 200,000	0.48	0.28	0.28
Over 200,000 to 300,000	0.58	0.33	0.33

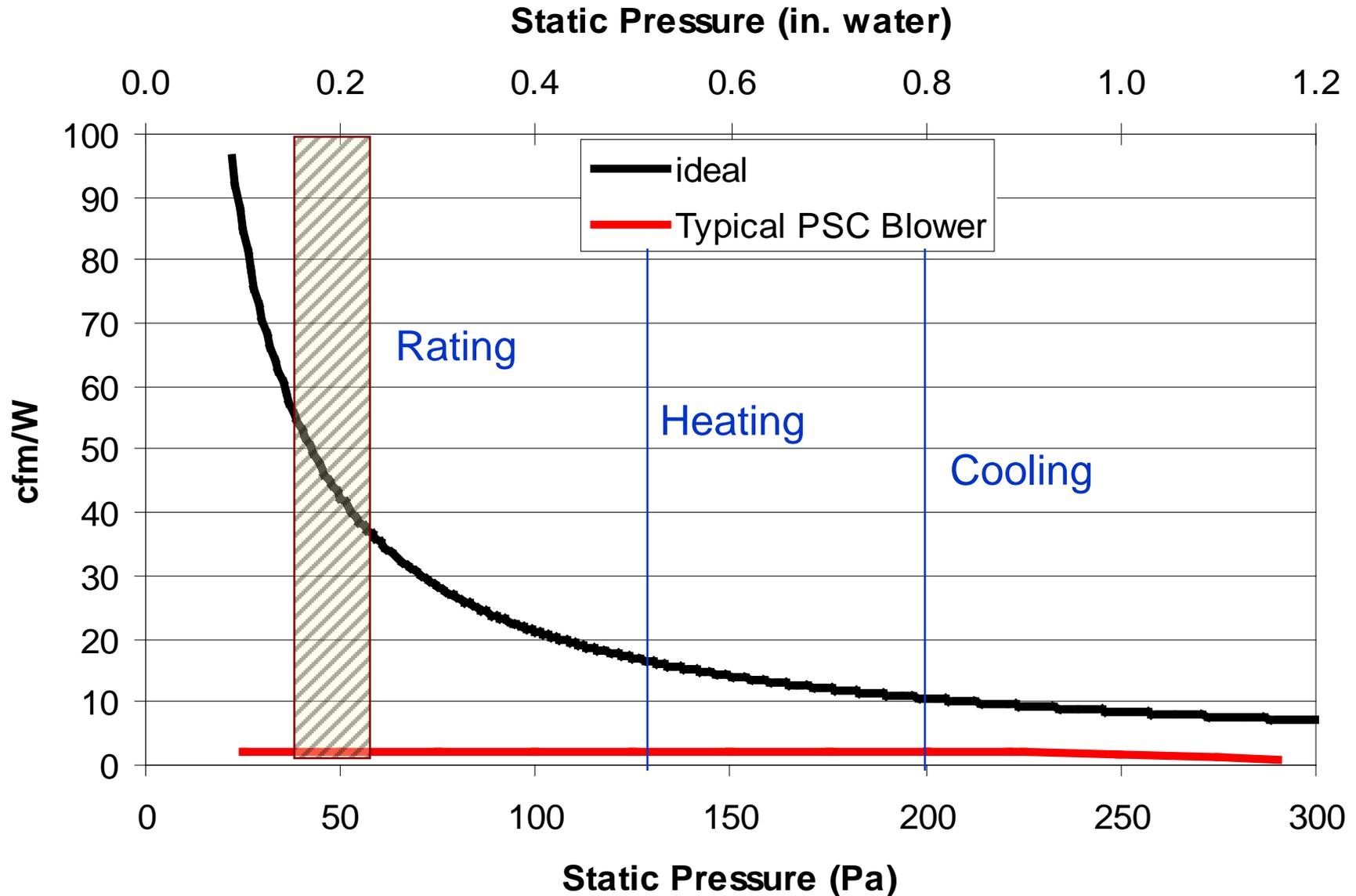
*These static pressures apply for operation at maximum rated input only.

Table 6. Minimum External Pressure

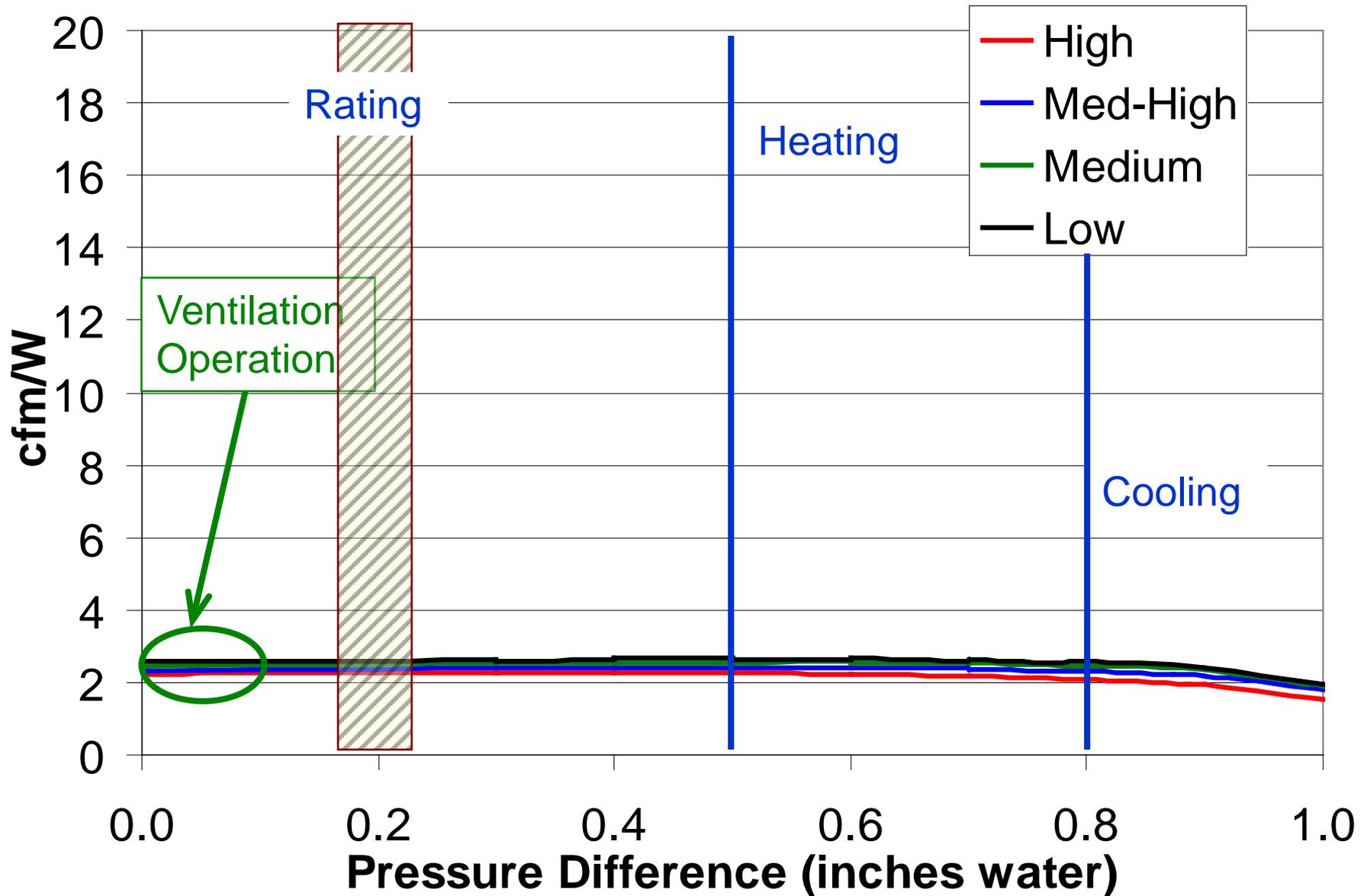
Standard Capacity Ratings ¹		Minimum External Resistance	
MBtu/h	kW	in H ₂ O	Pa
≤ 28	≤ 8.2	0.10	25
> 28 and ≤ 42	> 8.2 and ≤ 12.4	0.15	37
> 42 and < 65	> 12.4 and ≤ 19.0	0.20	50

¹ Cooling capacity for units with cooling function; High Temperature Heating Capacity for heating-only units

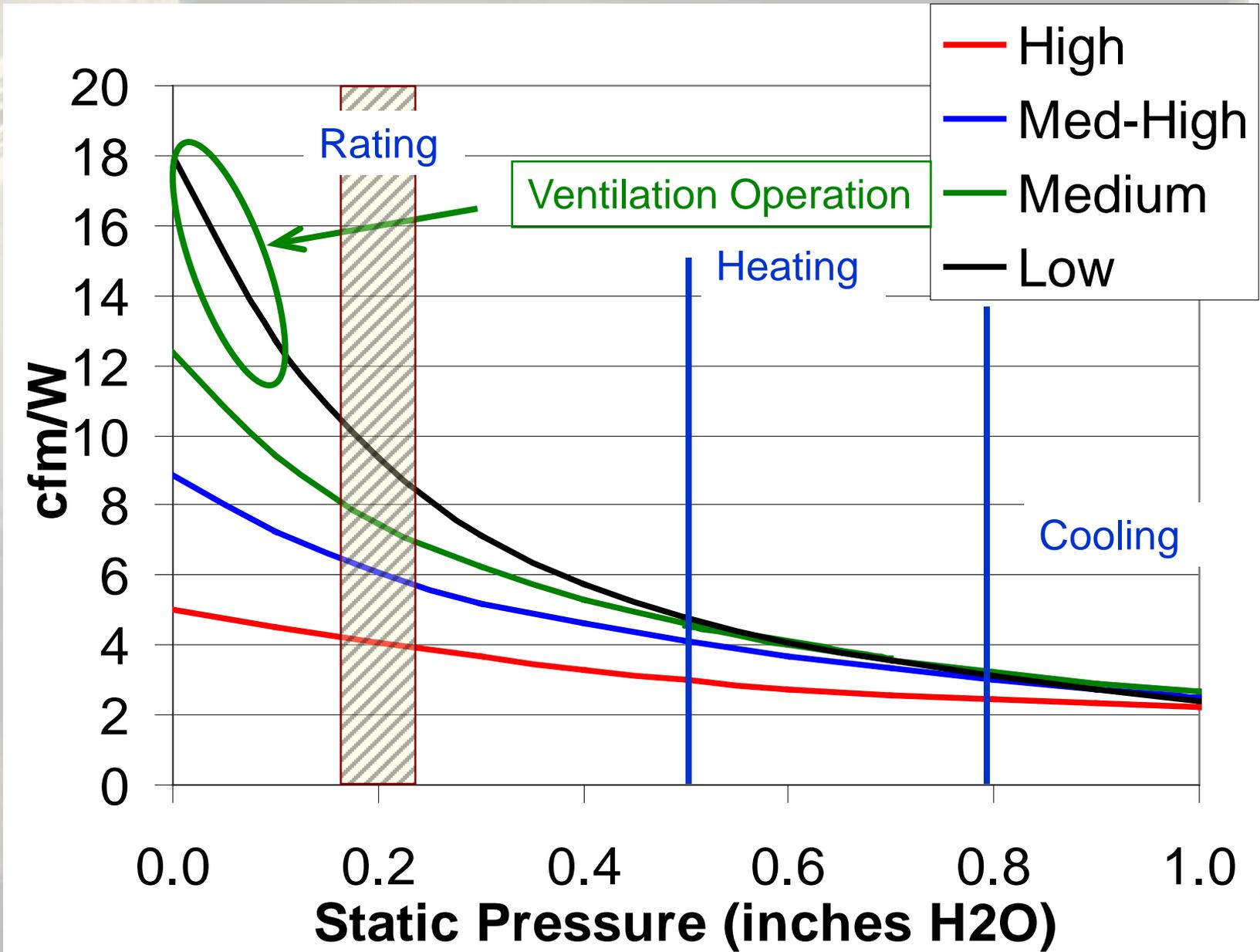
Low pressures = (potentially) better



PSC has same performance at all pressures



BPM has better performance at low pressures



How to improve performance

Better motor - only current equipment option is to use BPM

BPM improvements achieved only with:

- Good ducts – avoid small ducts, single speed zoning
- Better filters
- Multi-capacity equipment

Use two smaller 2.5 ton systems instead of one large 5 ton system

Better aerodynamics in the future?

Codes/Standards

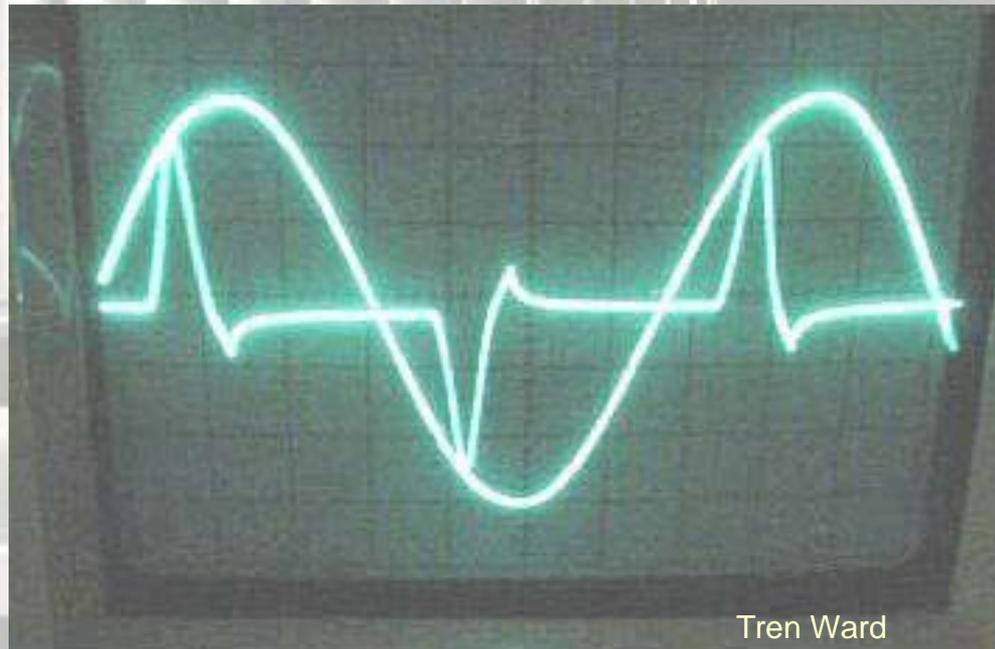
- DOE/AFUE/ARI low pressure testing gives big BPM benefit not reflected in typical applications
- EPA Act and utility credits are for using BPMs
- T24 credit for good blowers
 - Requires field testing at maximum speed
 - Relative to (580 W/1000 cfm) or 1.7 cfm/W
- CSA 823 coming soon – lab test at several setpoints for rating – uses fixed pressure at heating speed to fix system curve

Summary

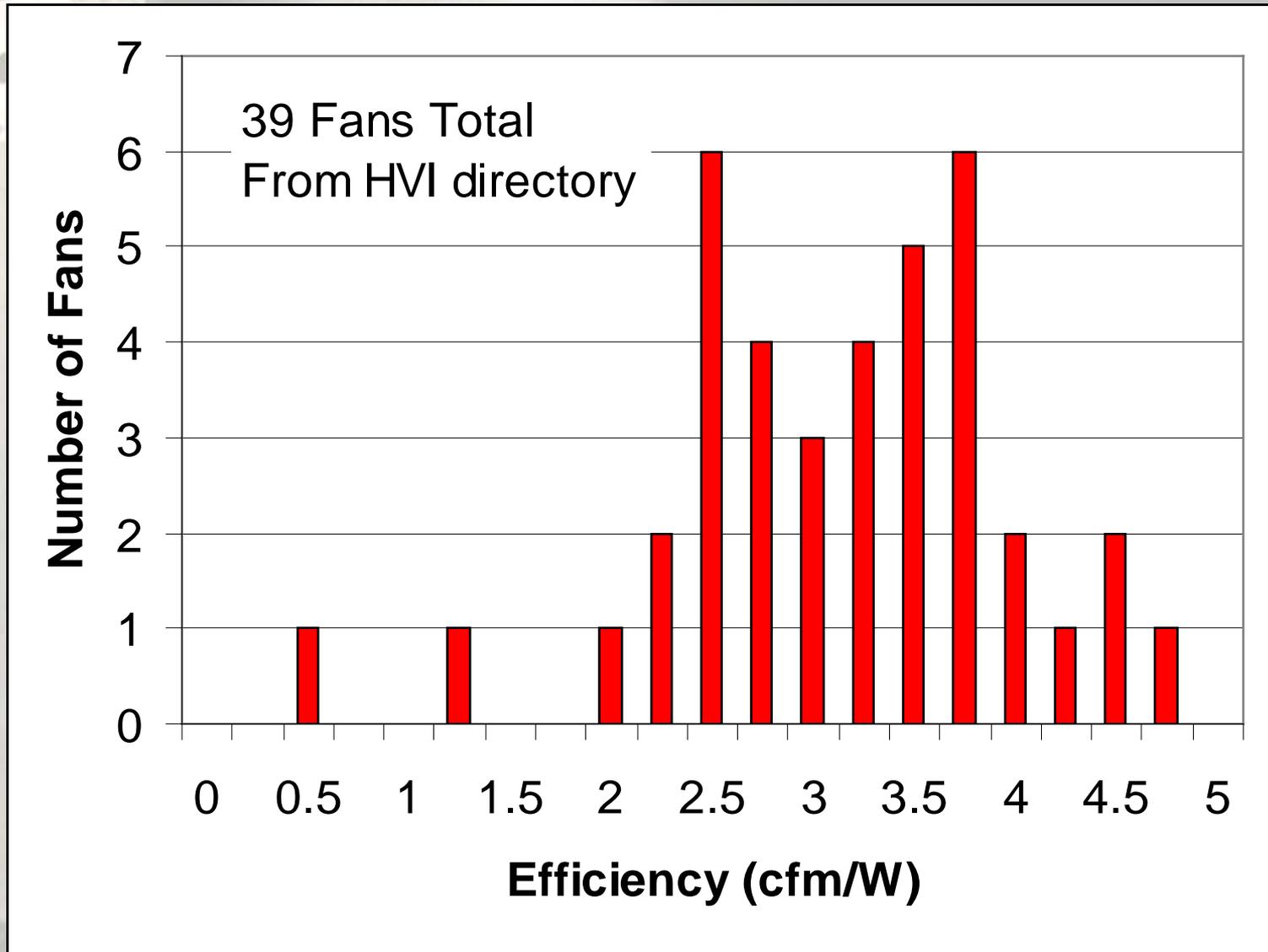
- Recommend changing rating procedure test pressures to 0.5 in. water for AFUE and 0.8 in water for ARI cooling/heat pump
- Paths to lowering air handler electricity consumption:
 - Better motor
 - Better duct design, filter selection
 - Better installation – no compressed/bent flex
 - Avoid single speed zoning
 - Avoid 5 ton air air conditioners
 - Better aerodynamics in the future?

Power Factor Issues

- BPM motors have high frequency current spikes resulting in a low power factor
- PSC 0.7 to 0.9 decreases with higher pressure
- BPM 0.5 to 0.6 increases with higher pressure
- Utility concern - can be controlled



Ventilation Fans



HRVs

